

# Window of Infectivity

Kimberly Nigg, DDS

Michael Kanellis, DDS, MS

Department of Pediatric Dentistry  
University of Iowa

# Dental Caries

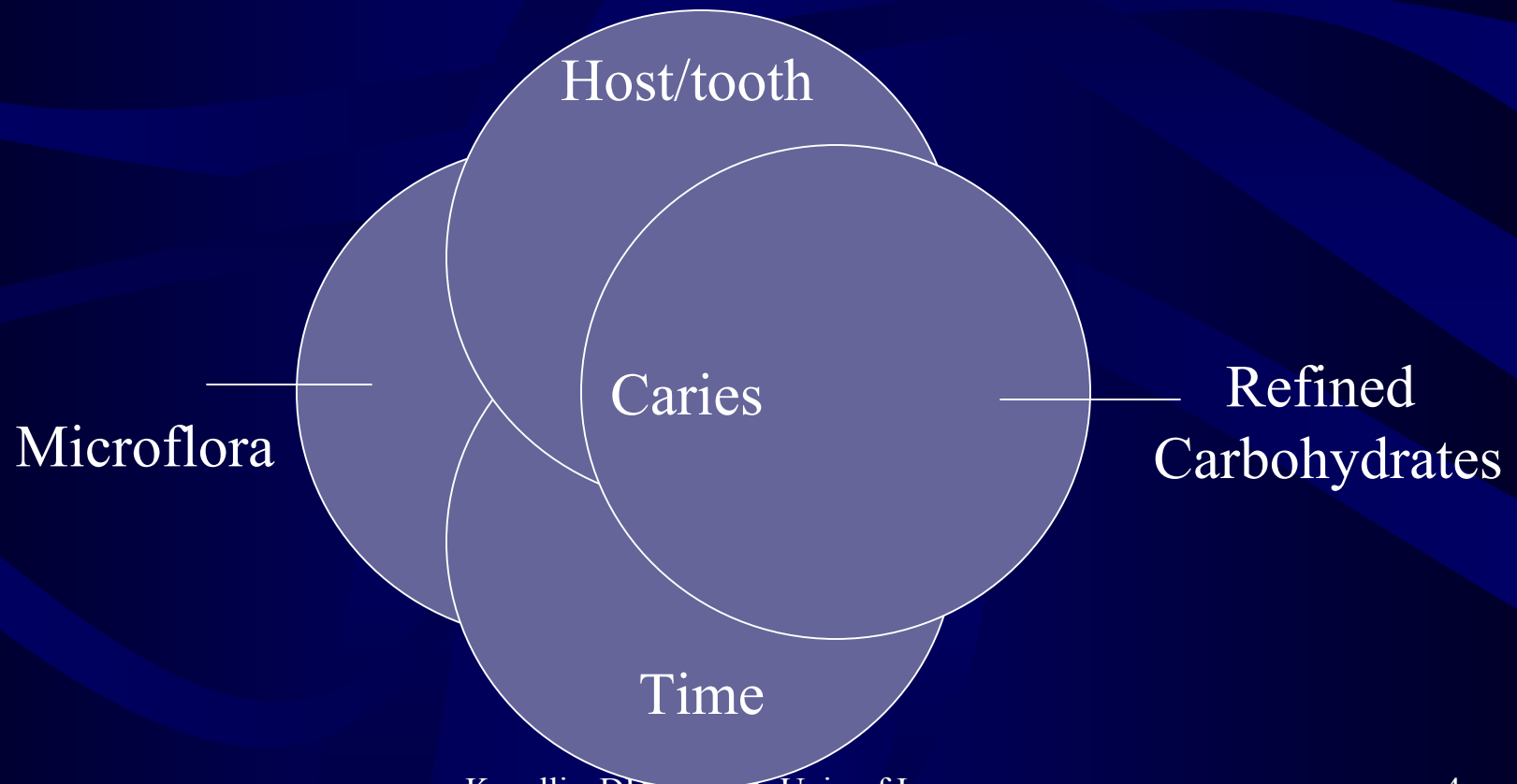
Multi-factorial  
Infectious  
Transmissible

# Current Concept - Caries Process

- Bacteria metabolize sugars and produce acid
- pH decreases and enamel demineralizes
- Bacterial colonization and acid production increase without oral hygiene
- Demineralization vs. Remineralization

# Dental Caries – Venn Diagram

Multi-factorial Disease Process



# Microbiology of Dental Caries

- Oral microflora - hundreds of bacteria species
- Cariogenic bacteria must:
  - Contribute to the environment by producing organic acids (acidogenic)
  - Be able to withstand/proliferate in acidic environment (aciduric)

# Microbiology of Dental Caries

- Three cariogenic bacteria
  - *Mutans Streptococci (MS)*
    - *S. mutans*, *S. sobrinus*, *S. sanguinis*, *S. salivarius*, *S. milleri*
  - *Lactobacilli*
    - *L. acidophilus*, *L. casei*
  - *Actinomyces*
- While not the first to colonize the tooth, studies have shown *S. mutans* to be the main culprit in dental caries

# MS and Dental Caries

- 1960 – Keyes demonstrated that dental caries in animals is an infectious, transmissible disease
- 1975 – Mutans Streptococci (MS) implicated as the principle bacterial component responsible for dental caries in Humans

# MS and Dental Caries

- Infants do not harbor MS until after teeth emerge
- MS requires the presence of a hard and non-desquamating surface for their colonization

# The Window of Infectivity

- In 1993, Page Caufield and Colleagues presented a paper with evidence to support a discrete “window of infectivity” for MS colonization
- Oral bacterial levels of 46 mother-child pairs from infant birth to age 5 were studied to determine the age of acquisition of Mutans Streptococci

# When does the window occur?

- 38 of 46 infants acquired MS at median of 26 months
- 25% by 19mths
- 75% by 31mths



# When does the “Window” end?

- Window appears to close after all primary teeth erupt
  - Once a stable plaque or biofilm covers the tooth surface, MS is less likely to be established
- Children ages 2-6 have been shown to be less susceptible to MS infection

# Recent Studies

- “Window of Infectivity” seen earlier than 19 months of age
  - Mohan (1998): 20% of the children in the study were infected by 14 months of age
  - Karn (1998): Evidence of MS colonization as early as 10 months
  - Milgrom (2000): MS colonization seen at 6 months.
  - Milgrom (2000): Colonization noted in pre-dentate children (4/16)

## 2<sup>nd</sup> Window of Infectivity

- A 2<sup>nd</sup> window is speculated at approximately 6 years of age when 1<sup>st</sup> molars are erupting
- Straetemans (1998) found that about 75% of children uninfected at age 5 became infected by age 11

# How is MS transmitted?

Vertical

Horizontal

# Transmission of MS

## Why is mother the culprit?

- Most intimate contact (sharing utensils, kissing, etc.,)
- Immunologic factors transferred from mother to child (*in utero* and through breast feeding)
- Spends the most time with the child

# Transmission of MS

## Mother - child

- Mother-child pairs found to harbor the same *S. mutans* strains
- Quantitative amounts positively correlated between mother and child pairs
- Children whose mothers are the primary caretaker during the 1<sup>st</sup> 2 years of life are found to have more MS than children with other caretakers

# Transmission of MS

## Y Li & Caufield (1995)

- DNA fingerprinting of 34 mother-infant and of 7 fathers who lived in the same household
- 24/34 (70.6%) infants harbored identical genotypes of MS identical to mothers
- None of the infant DNA fingerprint patterns matched the fathers' strain
- MS transmission from mother to child
  - Female offspring 88%
  - Male offspring 53%

# Transmission of MS

## Emanuelsson (1998)

- DNA fingerprinting of 25 3yr old children – mothers and 18 fathers
  - 5 children showed MS genotypes different than parents
  - 6 children showed MS genotypes similar to the mother
  - No children harbored similar genotypes to fathers
- Study suggests that children can acquire MS outside and inside the family

# Transmission of MS

## Kosai (2000)

- DNA fingerprinting of 76 subjects from 20 families in Japan
- 144 genotypes containing 144 Streptococci mutans
- 70 genotypes found in children
  - 36 (51.4%) in agreement with their mothers
  - 22 (31.4%) in agreement with their fathers
  - 12 (18.6%) did not correspond with either parent
- Results conclude transmission could be from father or other source besides the mother

# Transmission of MS

## Mattos-Graner (2001)

- *S.mutans* isolated from 35 children in a Brazilian nursery (age 12-30m)
- 76 MS isolates were identified
- 2 unrelated children carried identical strains
- Conclusions- lateral transmission can occur among daycare children with prolonged exposure
  - daycare environments favor the spread of infectious agents

# Other factors affecting the acquisition of MS

- # of erupted teeth
- Presence of enamel hypoplasia
- Diet high in sweets (fermentable carbohydrates)
  - Content, consistency, frequency
- Antibiotic Intake (?)
  - Conflicting results
  - Pediatric suspensions contain sugar
  - Sick children may have poor dental and general overall health practices
  - Sick children are different immunologically

# Importance of these studies

- Important in understanding the etiology of Early Childhood Caries (ECC)
- Prevention or delay of ECC could be accomplished by prolonging the time which the child remains MS free
- Preventive strategies should begin early, probably during pregnancy

What considerations should a  
dentist make in private practice?  
In a public health practice?

# Prevention

- Primary Prevention
  - Goal: prevent damage caused by bacteria from occurring in the child's healthy mouth by controlling the substrate and providing aggressive oral hygiene measures
- Primary-Primary Prevention
  - Goal: educate and treat the mother in an attempt to prevent or minimize the spread of infection to her infant

# Anticipatory Guidance

- Proactive counseling process in which parents are questioned about their child's level of dental development
- Risk assessment is used to identify areas in which education/intervention is needed
- Process of anticipatory guidance would begin with the 1<sup>st</sup> dental appointment and would continue as the child matures
- Reassess child's needs at each visit and modify anticipatory guidance as needed

# Microbiological Monitoring

- Determine MS levels of children and their mother/father
- Information provides the dentist with the basis for implementing a prevention program for high-risk families
- Microbiological-based intervention can influence the level and timing of MS colonization
  - 10% povidone iodine
  - Chlorhexidine varnish or gel

# Interventions

- Lower MS in mothers
  - Diet counseling
  - Chlorhexidine
  - Fluoride
  - Regular oral hygiene and dental care
- Educate family
  - Diet, oral hygiene, fluoride, transmission

# Interventions

- Need to see children early
  - AAPD recommends that children receive their first dental visit by age 1
- Considerations for children with a high caries risk
  - Diet counseling
    - Reduce fermentable carbohydrates
  - Fluoride supplements
    - Systemic or topical
  - Chlorhexidine
  - Sealants

# Are prevention programs successful?

# Prevention Programs

- Köhler (1994): preventive program with mothers and 1<sup>st</sup> born children until 3yrs old
  - Counseling, prophylaxis, fl-, OHI, Chlorhexidine
- Study showed successful reduction of MS in mothers during the eruption of primary dentition in child can prevent or delay colonization of MS
- Delayed in colonization can reduce the development of caries
- Follow-up of children at 7yrs old showed long-term effects: less caries experience in test vs. control group

# Summary

- “Window of Infectivity” is used to describe the time period when children are at greatest risk for acquiring MS
- MS colonization occurs between 19 – 31 months of age, but has been seen as early as 10 months in some populations/studies
- A second “window” is speculated to occur when 1<sup>st</sup> molars are erupting

# Summary

- Although the mother has been implicated as the primary source of infection, it is noted that MS colonization can occur from other sources
- By using Anticipatory Guidance a dentist can identify infants/families at high risk for caries
- To prevent dental disease, clinicians must do risk assessment, preventive counseling, and preventive interventions at an early age

# References

- Udin: Newer Approaches to Preventing Dental Caries in Children. California Dental Association Journal Vol. 27, No. 11; 843-851, Nov 1999
- Straetemans, van Loveren, de Soet, de Graaff, ten Cate: Colonization with Mutans Streptococci and Lactobacilli and the Caries Experience of Children after the age of Five. J Dent Res 77 (10): 1851-1855, Oct 1998
- Li, Caufield: The Fidelity of Initial Acquisition of Mutans Streptococci by Infants from their Mothers. J Dent Res 74(2); 681-685, Feb 1995
- van Loveren, Buijs, Cate: Similarity of Bacteriocin Activity Profiles of Mutans Streptococci within the Family when the Children Acquire the Strains after the age of Five. Caries Res 34; 481-485, 2000
- Kozai, et al: Intrafamilial Distribution of Mutans Streptococci in Japanese Families and Possibility of Father-to-Child Transmission
- Caufield et al: Initial Acquisition of Mutans Streptococci by Infants: Evidence for a Discrete Window of Infectivity. J Dent Res 72(1):37-45, Jan 1993
- Brambilla et al: Caries Prevention During Pregnancy: Results of a 30-month study. JADA, Vol. 129, July 1998, 871-877
- Karn et al: Colonization of Mutans Streptococci in 8- to 15-month-old Children. J Public Health Dent 1998; 58(3):248-9
- Caufield et al: Natural History of Streptococcus sanguinis in the Oral Cavity of Infants: Evidence for a Discrete Window of Infectivity. Infection and Immunity Vol. 68 No. 7; 4018-4023, July 2000
- Mattos-Graner, et al: Genotypic Diversity of Mutans Streptococci in Brazilian Nursery Children Suggests Horizontal Transmission. J of Clin Microbiology, Vol. 39 No. 6: 2313-2316, June 2001